ENVIRONMENTAL ANALYSIS & CONTROL RESPONSE TO QUESTIONS FROM THE COLORADO DEPARTMENT OF HEALTH ON THE ROCKY FLATS PLANT FLUIDIZED BED INCINERATOR HEPA FILTER SYSTEMS

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INTRODUCTION

Projected air emissions, air concentrations, and radiation dose at the Plant boundary from both the Trial Burn (verification run) and routine operations of the Rocky Flats Fluidized Bed Incinerator are calculated in the "Rocky Flats Plant Fluidized Bed Incinerator Radioactive Emissions and Health Risks" report.(RO87) Included in the report are proposed waste feeds for the Trial Burn and projected feeds for routine operations. The amount of radioactive material in the Trial Burn feed will be controlled for the runs involved; radioactive materials in routine operations feed are conservatively estimated to overestimate the resulting emissions, concentrations, and radiation doses. Both uranium and plutonium will be included in Trial Burn runs, with uranium runs preceding the plutonium runs.

Calculated radioactive emissions, air concentrations, and offsite radiation doses are based on the assumption of a minimum of five stages of High Efficiency Particulate Air (HEPA) filters which would filter particulates from any air leaving the FBI. The assumed filtration efficiencies for the HEPA filters are 99.95% for the first stage and 99.8% for each of the subsequent four stages. The total reduction factor for the five stages of filters is 8×10^{-15}. The assumed efficiencies are considered to be conservatively low, based on extensive experience which the Department of Energy and the Rocky Flats Plant have with HEPA systems.

SPECIFICATIONS AND TESTING

The HEPA filters currently used at the Rocky Flats Plant in the FBI are of the 5-7% Nomex^{R} type, size 5 filter, rated at 1,000 cfm. The basic standard for HEPA filters at Rocky Flats is found in SMU-401, "Standard for HEPA Filter, General Purpose.(RO82) Filters are ordered according to specifications found in Department of Energy (DOE) Nuclear Standard NE F 3-45, "Specifications for HEPA Filters Used by DOE Contractors."(US86a) Department of Defense (DOD) Military Specification MIL-F-51079, "Military Specification: Filter Medium, Fire-Resistant, High-

117

Efficiency," is the basic standard for HEPA filter media and DOD Military Specification MIL-F-51068, "Military Specification: Filter, Particulate, High-Efficiency, Fire Resistant," specifies required qualification tests on the filters.(DD80, DD81) Both of these specifications are referenced in NE F 3-45.

Other applicable DOE Nuclear Standards include NE F 3-42, "Operating Policy of DOE Filter Test Program," NE F 3-43, "Quality Assurance Testing of HEPA Filters," and NE F 3-44, "DOE Filter Test Facilities Quality Program Plan."(US86b, US86c, US86d)

The Rocky Flats Plant follows the American National Standard/American Society of Mechanical Engineers standard ANSI/ASME N509, "Nuclear Power Plant Air Cleaning Units and Components," regarding design, size, construction, and radiation resistance of its HEPA systems.(AM76)

Vendor qualification testing of filters is conducted at Edgewood Arsenal in accordance with requirements in MIL-F-51068. MIL-F-51068 includes performance requirements on DOP smoke penetration, resistance to airflow, resistance to rough handling, resistance to pressure, conditioning, resistance to heated air, spot flame resistance, resistance to environmental exposure, and workmanship.

Additionally, candidate filters are tested by Underwriters Laboratory (UL) for UL approval under the American National Standards Institute (ANSI) standard ANSI/UL-586, "Standard for Test Performance of High Efficiency, Particulate, Air Filter Units."(UL77) Tests are for efficiency, DOP (Dioctyl phthalate) penetration, moist air, heated air, spot flame, and low temperature performance.

Upon arrival at Rocky Flats, each individual HEPA is tested prior to use to ensure that its particulate filtration efficiency is at least 99.97%. Testing is performed in accordance with Plant Services Department Procedure FILT. CERT-SOP-1, "HEPA Filter Testing, Q107 DOP Penetrometer."(RO85)

In actual experience, most filters meet or exceed a filtration efficiency of 99.99%. Testing is performed with monodispersed DOP particles of 0.3 um NMD (Number Mean Diameter), measured with a Q107 DOP penetrometer. An NMD of 0.3 um is the ANSI/ASME-recognized nominal particulate size for minimum filter efficiency. The actual size which is most penetrating through a filter may differ somewhat from this value. Particulates larger than this size are filtered more efficiently because of increased occurrence of impaction and interference; particulates smaller than this size are filtered more efficiently because of increased diffusion into the filter and increased electrostatic precipitation.

Three out of every 350 filters received at Rocky Flats also are tested for compliance with MIL-F-51068 heated air, high

2

resistance, and resistance to rough handling specifications. The heated air test is conducted at ≥700 ±50 degrees F. Experience has shown very little filter deterioration. Filters often retain a filtration efficiency of ≥99.97%, even though only 97% is required by this test.

ANSI/ASME N510, "Testing of Nuclear Air-Cleaning Systems," provides the basis for the field testing of the Rocky Flats HEPA filter systems.(AM80) Installed filter banks are leak tested in place to ensure that penetration of the test aerosol is less than 0.05% overall for each filter bank. For this test, polydispersed DOP particles are used of 0.7 um NMD, having a size range of 0.1 to 3 um. Each filter within the bank is tested individually in place. The entire bank is then tested to ensure penetration of ≤0.05%.

Other DOE facilities besides Rocky Flats use HEPA filters for particulate emissions control. Los Alamos Scientific Laboratory (LASL) has conducted research on the performance of multiple stages of HEPA filters against plutonium oxide aerosols of varying particle sizes. A LASL report issued in 1976 concludes, "Although penetration increased at each succeeding stage and the aerosol size distribution was modified to a more penetrating range, mean penetration of each stage remained generally below 0.0002 [filtration efficiency of 99.98%] under half- and full-flow conditions."(GO76)

No gaseous radioactive constituents are anticipated in the FBI operation. The primary and secondary reaction chambers will operate at about 1000 degrees F. Effluent air will pass through a heat exchanger which will lower the temperature to less than 125 degrees F before it reaches the FBI HEPA prefilters. The boiling points of plutonium and uranium metal are much higher than these temperatures - 5800 and 7500 degrees F, respectively. The vapor pressure of the oxide forms which will be generated in the FBI are even lower than those of the metals.

MAINTENANCE AND SECURITY

Pressure differentials across each filter bank are measured continuously using Magnehelic® gauges. Readings on the gauges are inspected at the plenum and recorded monthly. Filters are changed when visual inspection or DOP testing indicate that change is appropriate or when the pressure differential reaches ~3 inches of water. The manufacturer certifies filter performance for a differential of up to 5 inches of water. In general, filter efficiency improves as filter loading occurs, within the filter design criteria. A continuous flow recorder for the exiting air stream from the FBI plenum has a readout in the Building Utilities Control Room. Tandem filter banks provide for backup filtration capability should a filter bank be damaged, but even damaged filter banks can provide significant filtration capability, depending on the extent of the damage.

The filter plenum which houses the last four filter banks serving the FBI is kept locked when unattended. Only authorized personnel may sign out the key to the plenum, and a log is kept of those personnel. The fourth filter stage and the plenum air lock are monitored monthly for radioactivity contamination by the Radiation Monitoring group at the Plant.

Two exhaust fans serve the FBI plenum. One operates continuously; the other serves as a standby unit. One of the fans is on emergency power, which allows operation on generator-produced power if standard building power is lost. All utilities controls and monitoring is on emergency power; this includes fans and their controls, radioactivity sampling and monitoring systems, and the heat detector alarm systems.

The filters themselves are fire resistant - as demonstrated in the heated air and spot flame tests - and combustible materials are not stored in the plenum area. A Temperature Indicating and Recording Alarm (TIRA) system activates an alarm and recorder in the Building Utilities Control room when air temperature in the FBI plenum reaches 120 degrees F. An inspection by the Utilities Operator would then determine the cause of the alarm and any corrective action. In addition, the plenum is equipped with two sprinkler deluge systems. The first is installed prior to a fire metal screen that precedes the 1st stage of the HEPA filters. This sprinkler system activates automatically (190 degrees F activation point) from a heat detector located in the ductwork prior to the fire metal screen. The screen prevents water carryover to the first HEPA stage. The second sprinkler system is located immediately before the 1st HEPA stage and is manually activated. HEPA filter requirements mandate a minimum 99.97% filtration efficiency for 1 hour even when filters are in an atmosphere of 100% relative humidity and under a pressure differential of 10 inches of water. The 190 degree heat detector triggers audible alarms in the building, at the Fire Department, at Plant Security, and audible and visual alarms at the Building Utilities Control Room. The building has its own Building Emergency Support Team, trained in immediate response to an alarm, and the Plant has a fully trained and equipped Fire Department which can respond within minutes of an alarm.

Spills of radioactive material within the building would remain contained in the building. Any aerosols would be subject to HEPA filtration in the exiting air stream. The plenum has a dedicated drain system that is part of the Plant Process Waste system. Plant surface water control includes a system of holding ponds for retention onsite of any outdoor liquid releases of materials which might ultimately be subject to surface water runoff.

The Rocky Flats Plant has an onsite Emergency Response Plan, as well as a Radiological Emergency Response Plan developed by the State of Colorado Division of Disaster Emergency Services (DODES). The State Plan is exercised annually and onsite emergency procedures are exercised frequently.

PROJECTED RADIOACTIVITY EMISSIONS AND RADIATION DOSES

Projected air emissions from the Trial Burn are calculated as 3×10^{-10} uCi of plutonium and 3×10^{-12} uCi of uranium. From routine operations, estimated emissions are 1×10^{-7} uCi per year for plutonium and 1×10^{-11} uCi per year for uranium. These emissions were calculated using assumptions that would tend to overestimate the emission values. For comparison, total Plant emissions for a year are typically about 10 - 20 uCi of plutonium and 20 - 40 uCi of uranium.

Projected radiation doses to a member of the public are 2×10^{-15} rem (50-year committed effective dose equivalent) from the Trial Burn and 7×10^{-13} rem per year from routine operations. These values may be compared with the radiation dose standard for public protection of 0.1 rem per year for continuous exposure. Radiation dose received by Denver area residents from naturally-occurring radiation is about 0.35 rem per year. The radiation dose standard is for doses received from sources other than natural background radiation and medical sources of radiation exposures.

SUMMARY

Calculated air emissions, air concentrations, and radiation doses at the Rocky Flats Plant boundary from both the Trial Burn and routine operations of the Fluidized Bed Incinerator are negligible. These calculations include particulate emissions reduction using High Efficiency Particulate Air (HEPA) filters for the air effluent from the FBI.

Adherence to stringent standards concerning HEPA filter design, construction, installation, maintenance, security, and testing ensures the proper performance of the HEPA filter system. Extensive experience at the Rocky Flats Plant and at other facilities has shown HEPA filter technology to be dependable and effective for the removal of airborne particulates.

REFERENCES

AM76 The American Society of Mechanical Engineers, "An American National Standard: Nuclear Power Plant Air Cleaning Units and Components," ANSI/ASME N509, ASME, United Engineering Center, 345 East 47th St, New York, NY 10017, 1976.

AM80 The American Society of Mechanical Engineers, "An American National Standard: Testing of Nuclear Air-Cleaning Systems," ANSI/ASME N510, ASME, United Engineering Center, 345 East 47th Street, New York, NY 10017, 1980.

DD80 Department of Defense, "Military Specification: Filter Medium, Fire-Resistant, High Efficiency," MIL-F-51079C, DOD, US Army Research and Development Command, DRDAR-TSC-S, Aberdeen Proving Ground, MD 21010, 4 March 1980.

DD81 Department of Defense, "Military Specification: Filter, Particulate, High-Efficiency, Fire Resistant," MIL-F-51068E, DOD, US Army Research and Development Command, DRDAR-TSC-S, Aberdeen Proving Ground, MD 21010, 6 Feb 1981.

GO76 Manuel Gonzales, et.al., "Performance of Multiple HEPA Filters Against Plutonium Aerosols," LA-6546, Los Alamos Scientific Laboratory of the University of California, Los, Alamos, New Mexico, Nov 1976.

RO82 Rockwell International, North American Space Operations, Rocky Flats Plant, "Standard for HEPA Filter, General Purpose," SMU-401, 1982.

RO85 Rockwell International, North American Space Operations, Rocky Flats Plant, "HEPA Filter Testing, Q107 DOP Penetrometer," FILT. CERT-SOP-1, 1985.

RO87 Rockwell International, North American Space Operations, Rocky Flats Plant, "Rocky Flats Plant Fluidized Bed Incinerator Radioactive Emissions and Health Risks," 1987.

UL 77 Underwriters Laboratories, "Standard for Test Performance of High Efficiency Particulate Air Filter Units," ANSI/UL 586, Underwriters Laboratories, Long Island, NY 11746, 1977.

US86a U.S. Department of Energy, Nuclear Standard, "Specifications for HEPA Filters Used by DOE Contractors," NE F 3-45, US DOE, Oak Ridge National Laboratory, PO Box Y, Oak Ridge Tennessee, Sept 1986.

US86b U.S. Department of Energy, Nuclear Standard, "Operating Policy of DOE Filter Test Program," NE F 3-42, US DOE, Oak Ridge National Laboratory, PO Box Y, Oak Ridge Tennessee, July 1986.

US86c U.S. Department of Energy, Nuclear Standard, "Quality Assurance Testing of HEPA Filters," NE F 3-43, US DOE, Oak Ridge

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US86d U.S. Department of Energy, Nuclear Standard, "DOE Filter Test Facilities Quality Program Plan," NE F 3-44, US DOE, Oak Ridge National Laboratory, PO Box Y, Oak Ridge Tennessee, July 1986.